Diversity and Evolution of Monocots
... orchids and palms ...

Lilioids - petaloid monocots

1. Terrestrial/epiphytes: plants typically not aquatic
2. Geophytes: herbaceous above ground with below ground modified perennial stems: bulbs, corms, rhizomes, tubers
3. Tepals: showy perianth in 2 series of 3 each; usually all petaloid, or outer series not green and sepal-like & with no bracts

Asparagales: *Orchidaceae - orchids

• finish the Asparagales by looking at the largest family - the orchids
*Orchidaceae - orchids

The family is diverse with about 880 genera and over 22,000 species, mainly of the tropics. Orchids are mycotrophic (= fungi dependent) lilioids; some are obligate mycotrophs.

Cypripedium acaule
Stemless lady-slipper

Corallorhiza striata
Striped coral root

Dactylorhiza majalis protocorm

*Orchidaceae - orchids

Orchids have a protocorm - a feature restricted to the family. It is a structure formed after germination and before the development of the seedling plant. It has no radicle but instead mycotrophic tissue.

Dendrobium branch epiphyte

*Orchidaceae - orchids

Cosmopolitan, but the majority of species are found in the tropics and subtropics, ranging from sea level to almost 5000 m in nearly all environments except open water and true desert. Habit varies from herb to vine, but more than half of the species are epiphytic.

Ionopsis twig epiphyte

Oncidium trunk epiphyte

*Orchidaceae - orchids

Survive in these epiphytic and other harsh environments via CAM photosynthesis, velamen, and leaf tubers, in addition to mycorrhizal association.
**Orchidaceae - orchids**

Specialized reproductive biology:
- unusual pollination systems
- labellum petal for landing platform
- pollen masses, reduced stamen number
- numerous, dust-like seeds

**Perfume industry**

*Eulaema* (euglossine)

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*A 2007 paper in Nature suggests that the orchid family is not recent, but of late Cretaceous origin*

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**Bulbophyllum nocturnum**

Only totally night blooming orchid

Fungal midge pollinated?

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**CA 3  COZ.2+1  A.3.2.1  G(3)**

- 6 tepals with labellum (flower resupinate or upside down)
- 3 or fewer stamens
- inferior gynoecium fused at top with stamens to form column
- capsule
**Orchidaceae - orchids**

*Givnish et al. (2015) plastome tree*

- **Orchidoideae**
  - Five subfamilies
    - 3 stamens
    - 2 stamens
    - 1 stamen

- **Epidendroideae**
  - Two origins of reduction to one stamen

- **Cypripedioideae**

- **Vanilloideae**

- **Apostasioideae**

**Apostasioideae (2 genera)**

- 3 stamens (usually)
- Most primitive of orchids with nearly actinomorphic flowers
- Austral-asian distribution

**Vanilloideae**

The vanillloid orchids are a small tropical group of lianas, that includes *Vanilla*

*Neuwiedia veratrifolia*
**Orchidaceae - orchids**

Cypripedioideae (5 genera)
- 2 stamens
- “slipper” labellum
- Northern Hemisphere distribution

The lower petal is elaborated into the labellum - the landing platform

Lady’s-slippers have two functional stamens with pollen masses
Deceptive pollination system for naïve bumblebees

Other lady’s-slippers ...

*Cypripedium acaule - stemless lady’s-slipper*

*Cypripedium arietinum - Ram’s-head lady’s-slipper threatened*

*Cypripedium calceolus - Yellow lady’s-slipper*
**Orchidaceae - orchids**

*Cypripedium reginae*
showy lady’s-slipper

*Cypripedium candidum*
white lady’s-slipper
Threatened, fen or calcareous soils

**Orchidaceae - orchids**

*Paphiopedilum*
Non-native bucket or slipper orchids

*Phragmipedium*

*Mexipedium*

**Orchidaceae - orchids**

All other orchids have only 1 functional stamen with one or two pollinia

The stamen is situated on a **column** formed by fusion with the top of the inferior gynoecium
**Orchidaceae - orchids**

Structure and position of pollinia and column allow for intricate and differential pollen placement on pollinators.

*Orchidaceae - orchids*

labellum
other 2 petals
3 sepals (one behind)

*Orchidaceae - orchids*

Orchidoideae
Epidendroideae
Cypripedioideae
Vanilloideae
Apostasioideae

Epidendroideae
The epidendroid orchids, the largest group, are predominantly epiphytes or lithophytes and include all the showy tropical genera.

*Orchidaceae - orchids*

Orchidoideae
Epidendroideae
Cypripedioideae
Vanilloideae
Apostasioideae

Orchidoideae
The orchidoid orchids are mostly terrestrials with tubers or fleshy rhizomes and include most temperate orchids.
*Orchidaceae - orchids

Aplectrum hyemale
Putty root, Adam and eve

*Orchidaceae - orchids

Calopogon tuberosus - grass pink
note the labellum on top!

*Orchidaceae - orchids

Goodyera pubescens
Rattlesnake plantain

*Orchidaceae - orchids

Corallorhiza trifida - Early coral root

*Orchidaceae - orchids

Goodyera tesselata
Rattlesnake plantain

Calypso bulbosa - calypso orchid
[threatened]

*Orchidaceae - orchids

Corallorhiza striata - Slipped coral root
*Orchidaceae - orchids

**Platanthera leucophaea**
Prairie fringed orchid
State endangered, Federally threatened

*Orchidaceae - orchids

**Pogonia ophioglossoides** - snake mouth
**Spiranthes cernua** - nodding ladies 'tresses

Lilioids

4 main groups:

- **Acorales** - sister to all monocots
- **Alismatids**
  - inc. Aroids - jack in the pulpit
- **Lilioids** (lilies, orchids, yams)
  - non-monophyletic
  - petaloid
- **Commelinids**
  - Arecales – palms
  - Commelinales – spiderwort
  - Zingiberales – banana
  - Poales
    - pineapple
    - grasses & sedges

Dioscoreales: Dioscoreaceae - yams

Small mainly tropical family, with viney stems and net-veined leaves. Fruits are 3-winged.

Source of edible yam; sources of steroids, cortisones, first oral contraceptives (diosgenin, progesterone)

**Dioscorea villosa** - wild yam
Dioscoreales: Dioscoreaceae - yams

Not to be confused with sweet potato - which belongs to Convolvulaceae - asterid.

speaking of the holidays . . .
sweet potatoes & yams

Dioscoreales: some mycotrophs!

Burmanniaceae
Thismiaceae

Pandanales: Pandanaceae - screw pine

Old world tropical family of trees and vines - palm like
**Pandanales: Cyclanthaceae - Panama Hat**

Neotropical family of 12 woody, palm-like, or liana genera
Unisexual flowers in “spathe/spadix” - mimic palms but 4 merous not 3 merous as in palms

**Pandanales: Velloziaceae**

Pantropical, often thickened stemmed, adapted to fire

**Commelinids**

4 main groups:
- Acorales - sister to all monocots
- Alismatids
  - inc. Arumids - jack in the pulpit
- Lilioids (lilies, orchids, yams)
  - non-monophyletic
  - petaloid
- Commelinids
  - Arecales – palms
  - Commelinales – spiderwort
  - Zingiberales – banana
  - Poales
    - pineapple
    - grasses & sedges
**Commelinids**

- largest group of monocots ranging from palms to grasses
- strongly monophyletic!
- bound ferulic acid in cell walls (fluoresce under UV with ammonium hydroxide added)
- this feature allowed placement of Dasypogonaceae

**Dasypogonaceae**

- largest group of monocots ranging from palms to grasses
- 4 genera - W Australia

**Commelinids**

- theme: reduction of flower, loss of nectar, loss of zoophily, evolution of bracts
- pickeral weed
- rapatead
- bromeliad

**Arecales - palms**

- the order has one family - also called Palmae
- 190 genera and 2400 species of trees and shrubs
- tropics, subtropics, deserts, Mediterranean biomes
**Arecaceae - palms**

- Rattan palms - a plant group that honors the Wallace Biogeographic Line
- Asian distribution with few species passing through Sulawesi or New Guinea

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**Arecaceae - palms**

Great morphological diversity: in stature

- Syagrus - lilliput palm of Paraguay
- *Jubaea* - Chilean wine palm

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**Arecaceae - palms**

Great morphological diversity: largest seed of seed plants

- *Lodoicea maldivica* - Seychelles palm or double nut

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*Island gigantism*
Great morphological diversity: largest leaf

V egetative characteristics

• "woody" stems via primary thickening meristem or diffuse secondary growth
• essentially hardened leaf bases
• single apical meristem: susceptible to frost
• oldest known functioning primary xylem and sieve tubes!

Vegetative characteristics

• palmate or pinnate “compound”, sheathing, plicate or folded
• cell death or abscission forms “compound” leaves

KNOX genes involved in making compound leaves not involved in palm leaves
*Arecaceae - palms

Floral characteristics
- inflorescence surrounded by spathe - once allied with aroids

*Arecaceae - palms

Floral characteristics
- flowers unisexual or bisexual

\[CA_3 \ CO_3 \ A_3,6,\infty \ G_3 \ or \ (3)\]

*Arecaceae - palms

Floral characteristics
- fruit a 1-seeded berry or drupe

*Arecaceae - palms

Classification: 5 subfamilies
- Calamoideae and Nypoideae are first diverging

Pantropical spiny genera

Calamus radicalis
Hawaii
**Arecaceae - palms**

Classification: 5 subfamilies
- Calamoideae and Nypoideae are first diverging

*Nypa fruticans*
- Salt marsh

One species but with widespread early Tertiary fossil occurrences

**Arecaceae - palms**

Important palms: food
- *Cocos nucifera* - coconut

**Arecaceae - palms**

Important palms: oil, wax
- *Elaeis* - oil palm

**Arecaceae - palms**

Important palms: food
- *Phoenix* - Date palm
*Arecaceae - palms

Important palms: horticulture

*Roystonea - Royal Palm
*Washingtonia – Mexican fan palm

*Jubaea chilensis – Chilean wine palm